

## 7 REFERENCES

- [1] H. Abegunawardana, D.Rathnayake and W.M.A.P.Jayathilaka, "characteristics of cattle farming systems in sri lanka," *National council of Sri Lanka*, vol. 1, pp. 25-38, 1997.
- [2] Ministry Of Agriculture And Livestock, "Sri Lanka live stock Statistics," Department of Agriculture, Peradeniya, 2012.
- [3] Department of Census and Statistics, Central Bank Annual Report, 2012.
- [4] A.N.F.Perera, J. S.Siriwardana and S.Premarathne, "Fibrous Crop Residues as a Ruminant," *Handbook of veterinarians*, pp. 24-34, 1999.
- [5] P.McDonald, R.A.Edwards, J.F.D.Greenhalgh and C.A.Morgan, *Animal Nutrition*, India: Tan prints pvt Ltd, 1988, pp. 335-426.
- [6] M.N.M.Ibrahim and T.N.Jayathileka, "Livestock Production under coconut plantations in Sri Lanka,Cattle and buffalo production systems," *Asian australian journal of Animal science*, vol. 13, pp. 60-67, 2000.
- [7] S.Ranawana, "Dairy industry in Sri Lanka," in *Research Department of people's bank head office*, colombo, 2008.
- [8] S.C.Somasiri, S.Premarathne, H.A.Abeysoma, C.M.B.Dematawewa and J.H.M.N.Satsara, "Effect of Gliricidia Leaf Meal Blocks on Intake," *Live Weight Grain and Milk Yield of Dairy Cows*, vol. 22, pp. 76-83, 2010.
- [9] "Sri Lanka live stock Statistics," Department of Agriculture and Livestock, Peradeniya, 2006.
- [10] B. Perera and M.C.N.Jayasooriya, "The Dairy industry in Sri Lanka:Current staus and future directions for a greater role in national development," *National Science Foundation*, vol. 36, pp. 115-126, 2008.
- [11] S.premarathne and M.C.N.Jayasooriya, "Straw and fodder base supplementation for buffaloes,Proceeding of changing role of the buffoloes in the millennium in asia.," *National Science foundation,Sri lanka*, pp. 197-207, 2006.

- [12] S.Premarathne, G.G.C.Premalal and V.P.Jayawardena, "Sustainable management of grassland resources for ruminant live stock production in Sri Lanka," *Tropical agricultural research and extension*, vol. 6, pp. 60-65, 2006.
- [13] M.N.M.Ibrahim, Dairy cattle production, Peradeniya: Printing Unit, Faculty of Agriculture, University of Peradeniya, 2000.
- [14] B.M.A.O.Perera, H.Abegunawardena, W.G.Vale and C.Chantalakhana, "Improving the husbandry of animals kept by poor people in developing countries," *Livestock and wealth Creation*, pp. 451-471, 2005.
- [15] S. K.Ranjhan, "Proceeding – Utilization of Agro-industrial by-products as Livestock Feed," *Modern approaches to feed evaluation and their application in India.* , no. New Delhi, 1993.
- [16] NRC, " Nutrient Requirement of dairy cattle. 6th Revised Edition," National Academy Press, Washington, DC, 1989.
- [17] A. R. C. (ARC), "The Nutrient Requirement of Ruminant Livestock," Commonwealth Agricultural Bureau, London, 1980.
- [18] C.A.Moran, "Nutritional requirements of dairy cattle," *Applied animal nutrition*, no. 2, pp. 100-107, 2005.
- [19] D.N.Verma, "Animal Nutrition," New Delhi, Kalyani Publishers, 1994, pp. 243-307.
- [20] K.Samarasinghe, "Feed and Feed formulation for poultry in Sri Lanka," Peradeniya, Department of animal science, Faculty of Agriculture, 2007, pp. 73-79.
- [21] C.A.Gopalakrishnan and G.M.M.Lal, "Livestock and poultry enterprises for rural development," New Delhi, Vikas publishing house, 1985, pp. 90-185.
- [22] N. R. Council, " Nutrient Requirement of dairy cattle, 7th Revised Edition, Subcommittee on Dairy Cattle Nutrition Committee on Animal Nutrition Board on Agriculture and Natural Resources," 2000.
- [23] 2015. [Online]. Available: <http://www.fao.org/docrep/015/i2728e/i2728e00.pdf>.

- [24] K.C.Das, N.Haque and C.Rajkhowa, "Tree leaves and forest grasses based feed block for Mithun in North Eastern region of India," *Proceedings of the national symposium on fodder block technology*, no. ILDEX India–2009, New Delhi, p. 80–83, 2009.
- [25] K.K.Singhal, "Scope for sugarcane bagasse based complete feed for ruminants," *Proceedings of the national symposium on fodder block technology*, no. ILDEX India–2009, New Delhi., pp. 93-98, 2009.
- [26] A.K.Samanta, K.K.Singh, M.M.Das, S.B.Maity and S. Kundu, " 2003. Effect of complete feed block on nutrient utilization and rumen fermentation in barbari goats," *Small Ruminant Research*, no. 48, p. 95–102, 2003.
- [27] T.K.Walli, " Densified TMR – A newer nutrient delivery system for feeding dairy animals in tropics," *XXXVI dairy industry conference*, no. BHU, Varanasi, India, p. 74–79, 2008 a,2009b,2010,2011.
- [28] M.R.Garg and B.M.Bhanderi, "Enhancing livestock productivity through balanced feeding," *In S.S. Kundu, C. Dutt, V. Mani & A. Kumar.Proceedings of the 14th Biennial Conference*, no. Animal Nutritional Society of India, Pantnagar University of Agricul, p. 11–21, 2011.
- [29] 2015. [Online]. Available: <http://www.new-ag.info/en/focus/focusItem>.
- [30] [Online]. Available: <http://www.agricultureinformation.com/postings/win-win-solution>.
- [31] R.Marchen, "Blocks and cub supplementation for Grazing Beef Cattle," *Texas cooperative extension*, 2005.
- [32] N. R. C. (NRC), "Feeding tables," 2001.
- [33] K. Kulathunga, "Preparation of cattle feed blocks using Agro waste," 2014.
- [34] Joseph E.Shigley, Charles R. Mischke, *Standard handbook of machine design*, New York: McGraw-Hill,USA, 1996.

## ANNEXES

### Annex 01: Specifications of the hydraulic system and the controlling method

#### Main hydraulic cylinder (second stage)

- Double acting hydraulic cylinder with front flange mounted 224 mm (9in) diameter 1000 mm stroke
- Maximum pressure applicable: 300 kg/cm<sup>2</sup>
- Ram diameter : 160 mm

#### First stage hydraulic cylinder

- Double acting hydraulic cylinder with front flange mounted 63 mm (2.5in) diameter 900 mm stroke
- Maximum pressure applicable: 250 kg/cm<sup>2</sup>
- Hopper door operating hydraulic cylinder  
Double acting hydraulic cylinder with front flange mounted 50 mm (2in) diameter 400 mm stroke
- Maximum pressure applicable: 250 kg/cm<sup>2</sup>

#### Hydraulic pump (Vane type)

- Volume flow rate low pressure :110 l/min
- Volume flow rate high pressure: 10 l/min
- Maximum pressure : 250 kg/cm<sup>2</sup>

#### Hydraulic oil

- Hydraulic oil (HD 68) quantity :200l

#### Motor

- Three phase 15 hp induction motor, 415 V, 50 Hz

#### Hydraulic controllers

- 02 Nos of 4/3 way solenoid valves with manifold block, oil flow rate : 80 l/min (Port size 1/4" Dia, 1/2" hydraulic hoses)
- 01 Nos of 4/3 way solenoid valves with manifold block, oil flow rate : 300

l/min ( Port size  $\frac{3}{4}$ " Dia, 1  $\frac{1}{4}$ " hydraulic hoses) with regeneration for main cylinder

#### Other hydraulic accessories

- Pressure relief valve, max pressure 300 kg/cm<sup>2</sup>
- Electric pressure cutoff valve fixed to the main cylinder front moment
- Oil reservoir tank with capacity of 200l, with suction filter, oil filter, level gauge
- 150 l/min capacity water cooling type oil cooler.

#### Equipment of Electrical control panel

- Programmable logic controllers with 10 nos relay outputs, 10 no of digital inputs with 230 V operating voltage
- Metal enclosures, Electro Zinc coated sheet steel 2 mm thick with powder coated beige in textures finished, Hinged door & rubber gasket, ABC Key lock, Grand plate, Mounting plate, IP 54, IEC 529 standards, size 400 mm \* 600 mm \* 200 mm
- 06 Nos Goose neck type electric limit switches

#### Annex 02: Ladder diagram for PLC programming

##### Notations

##### Inputs

Input	Definition
X0	Cycle start
X1	Initial position of door (door open)
X2	closed position of door (door closed)
X3	Initial position of first stage
X4	Pressed position of first stage
X5	Initial position of second stage
X6	Pressed position of second stage
X7	Manual door close
X10	Manual first stage compression
X11	Manual second stage compression
X12	Manual second stage return
X13	Manual door open

X14	Manual first stage return
X15	Auto mode
X16	Pressure cutoff switch
X17	Preset

### Outputs

Output	Definition
Y1	Door open
Y2	Door close
Y3	First stage return
Y4	First stage compression
Y5	Second stage return
Y6	Second stage compression
Y7	Error indicator (Buzzer+ red light)
Y10	Door closed alarm (bell)
Y11	High pressure check valve
Y12	Low pressure check valve
Y14	Material Loading (yellow light)
Y15	Auto mode indicator (green)

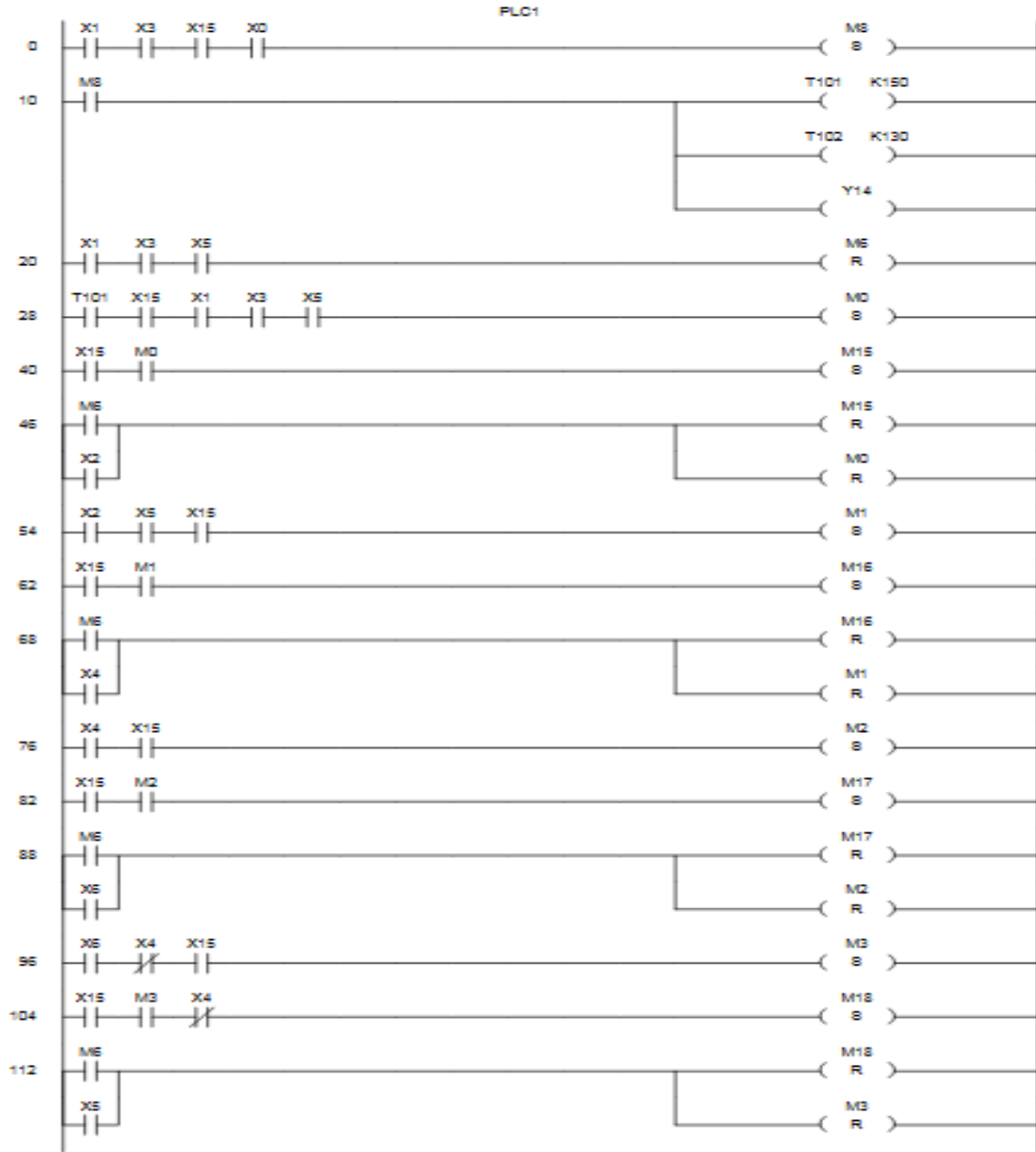
### Memory

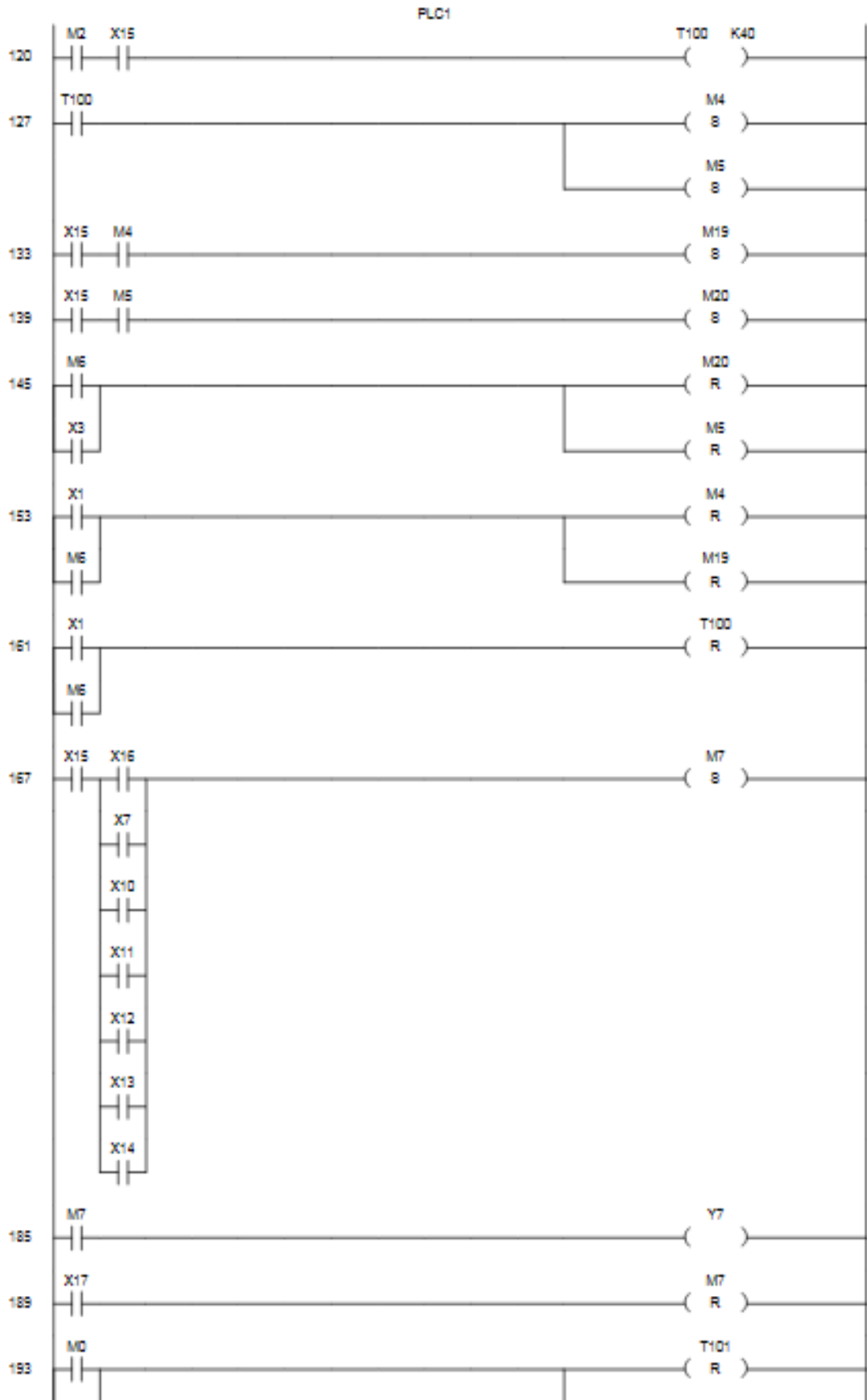
Memory	Definition
M0	Cycle start
M1	First stage compression
M2	Second stage compression
M3	Second stage return
M4	Door open
M5	First stage return
M6	Preset
M7	Error indicator
M8	Yellow light on
M15	Door close valve operation
M16	First stage compression valve

	operation
M17	Second stage compression valve operation
M18	Second stage return valve operation
M19	Door open valve operation
M20	First stage return valve operation

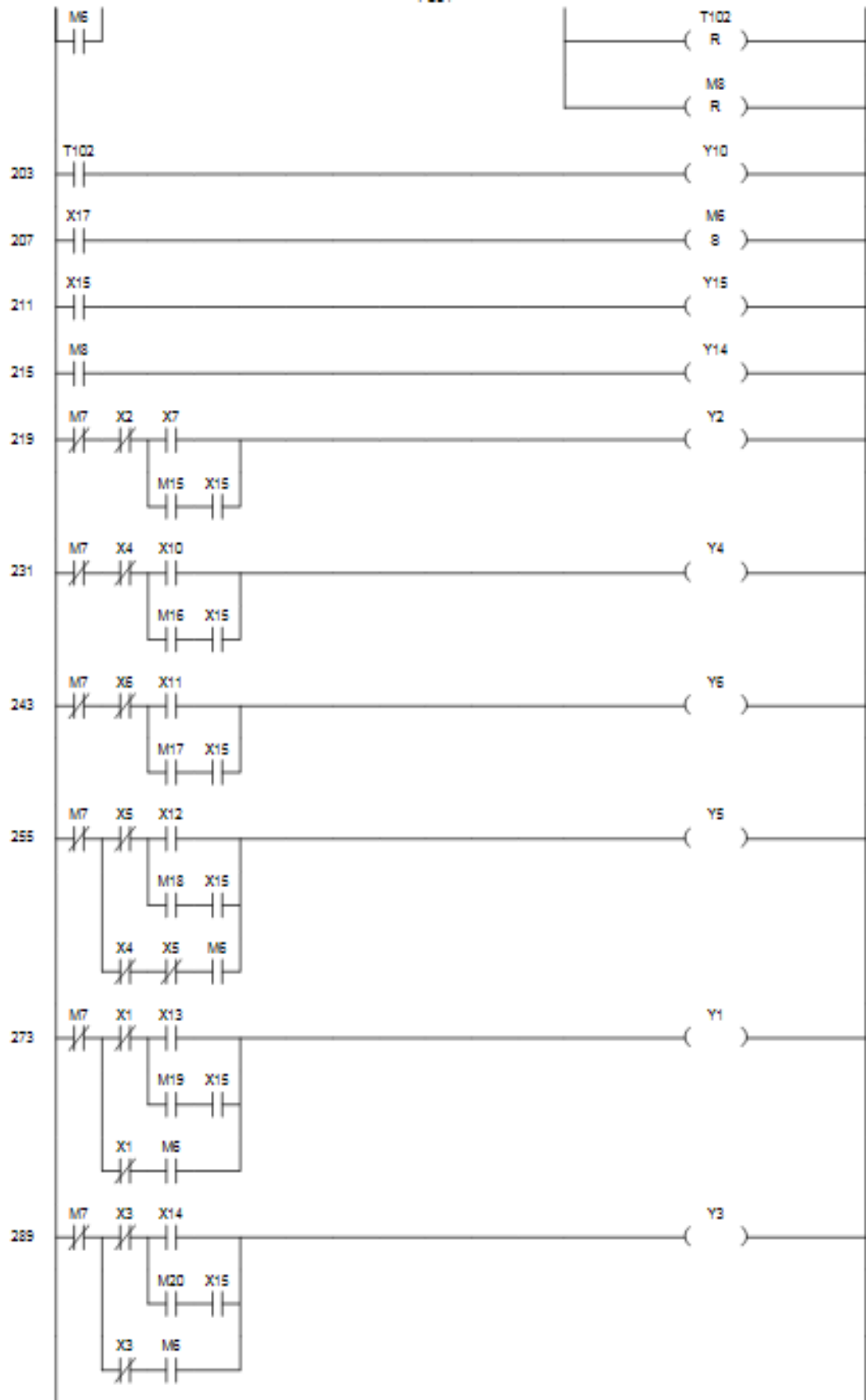
**Timers**

Timer	Definition
T100	Returning of first stage and door open
T101	Cycle start
T102	Cycle start with alarm (bell)









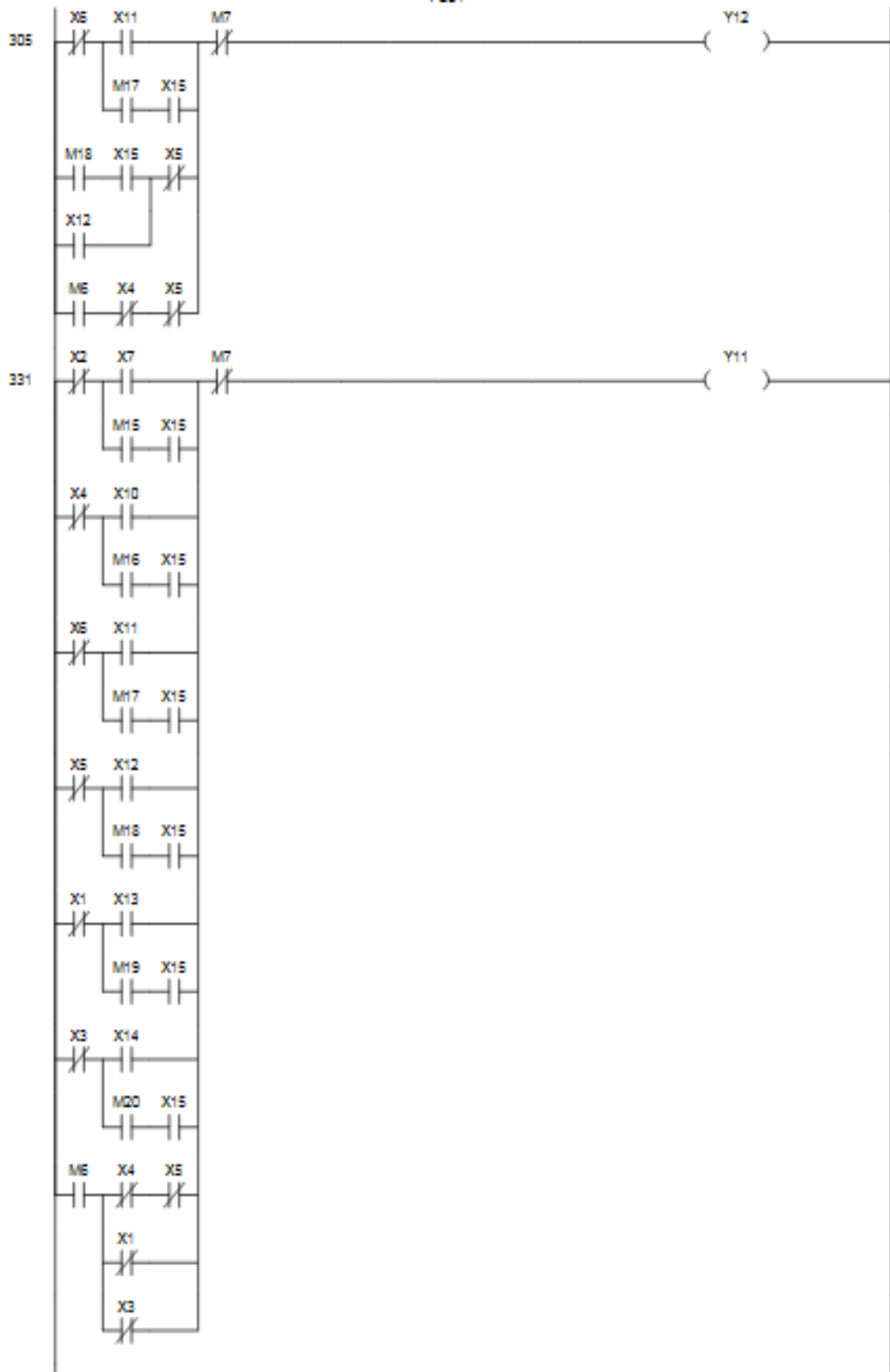


Figure A: Ladder diagram for PLC